

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
25 October 2001 (25.10.2001)

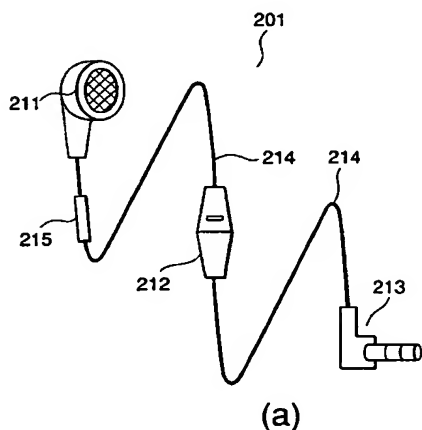
PCT

(10) International Publication Number  
**WO 01/80616 A2**

- (51) International Patent Classification<sup>7</sup>: **H05K 9/00**, (72) Inventors; and  
H04M 1/02 (75) Inventors/Applicants (for US only): **ONO, Hi-**  
**roshi** [JP/JP]; c/o Tokin Corporation, 7-1, Koriyama  
6-chome, Taihaku-ku, Sendai-shi, Miyagi 982-8510 (JP).  
**YOSHIDA, Shigeyoshi** [JP/JP]; c/o Tokin Corporation,  
7-1, Koriyama 6-chome, Taihaku-ku, Sendai-shi, Miyagi  
982-8510 (JP).
- (21) International Application Number: PCT/JP01/03271
- (22) International Filing Date: 17 April 2001 (17.04.2001)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
2000-114912 17 April 2000 (17.04.2000) JP  
2000-127191 27 April 2000 (27.04.2000) JP
- (74) Agent: **KURIHARA, Kiyoshi**; Nishikan Toranomon  
Bldg.4th fl., 22-13, Toranomon 1-chome, Minato-ku,  
Tokyo 105-0001 (JP).
- (81) Designated States (national): CN, KR, NO, SG, US.
- (84) Designated States (regional): European patent (DE, FI,  
FR, GB, SE).
- (71) Applicant (for all designated States except US): **TOKIN**  
**CORPORATION** [JP/JP]; 7-1, Koriyama 6-chome, Tai-  
haku-ku, Sendai-shi, Miyagi 982-8510 (JP).
- Published:  
— without international search report and to be republished  
upon receipt of that report

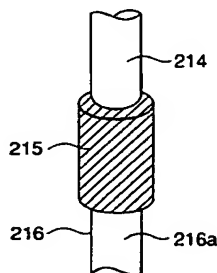
[Continued on next page]

(54) Title: HIGH-FREQUENCY CURRENT SUPPRESSOR CAPABLE OF BEING READILY ATTACHED TO CABLE OR THE LIKE AND EARPHONE SYSTEM USING THE SAME



(a)

(57) Abstract: An earphone system 201 comprises an earphone 211, a microphone 212, a connection plug 213, a signal cable 214 for connecting those, and a hollow cylindrical high-frequency current suppressor 215 attached to the signal cable 214 at a position near the earphone 211 with covering an external circumferential surface 216a of the cable housing 216. When used for a terminal equipment for mobile communication, high-frequency current generated by electromagnetic waves produced from the terminal equipment can be reduced. The earphone system 201 can prevent an increase of SAR value in human head.



(b)

WO 01/80616 A2



*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## DESCRIPTION

HIGH-FREQUENCY CURRENT SUPPRESSOR CAPABLE OF  
BEING READILY ATTACHED TO CABLE OR THE LIKE AND  
5 EARPHONE SYSTEM USING THE SAME

## TECHNICAL FIELD:

The present invention relates to a high-frequency current  
suppressor for suppressing high-frequency conduction noise in a  
10 signal transmission cable used for various electronic information  
equipment, such as a terminal equipment for mobile communication,  
an audio-visual equipment, or the like, and also to an earphone  
system using the high-frequency current suppressor.

## 15 BACKGROUND ART:

Conventionally, various signal transmission cables are  
used for transmitting signals between devices or between  
components in various electronic information equipment.

On the other hand, in various audio-visual equipment for  
20 enjoying music or movies, an earphone system including a signal  
transmission cable having a connection plug at its end, earphone or  
headphone is utilized to enable a user to enjoy music or movies  
without worrying about surrounding sound.

Further, an earphone system combining the above-  
25 described earphone or headphone for enjoying music etc. and a  
microphone has been used in recent years, for example, in a  
terminal equipment for mobile communication, such as a portable  
telephone, or the like. This makes hands-free communication

--This application is a U.S. National Phase Application  
under 35 USC 371 of International Application PCT/JP01/03271  
(published in English) filed April 17, 2001.--

## DESCRIPTION

HIGH-FREQUENCY CURRENT SUPPRESSOR CAPABLE OF  
BEING READILY ATTACHED TO CABLE OR THE LIKE AND  
5 EARPHONE SYSTEM USING THE SAME

## TECHNICAL FIELD:

The present invention relates to a high-frequency current  
suppressor for suppressing high-frequency conduction noise in a  
10 signal transmission cable used for various electronic information  
equipment, such as a terminal equipment for mobile communication,  
an audio-visual equipment, or the like, and also to an earphone  
system using the high-frequency current suppressor.

## 15 BACKGROUND ART:

Conventionally, various signal transmission cables are  
used for transmitting signals between devices or between  
components in various electronic information equipment.

On the other hand, in various audio-visual equipment for  
20 enjoying music or movies, an earphone system including a signal  
transmission cable having a connection plug at its end, earphone or  
headphone is utilized to enable a user to enjoy music or movies  
without worrying about surrounding sound.

Further, an earphone system combining the above-  
25 described earphone or headphone for enjoying music etc. and a  
microphone has been used in recent years, for example, in a  
terminal equipment for mobile communication, such as a portable  
telephone, or the like. This makes hands-free communication

available, namely makes it unnecessary for a user to hold the terminal equipment for mobile communication directly in his hand.

The earphone system including those earphones or headphones generally comprises a connection plug connected to an output terminal of a terminal equipment, an earphone or a headphone and/or a microphone, and a signal cable for connecting the connection plug with the earphone, or the like. A cable length of the signal cable ranges from several tens centimeters to a hundred and several tens centimeters. In addition, the cable length corresponds to order of wavelength in microwave band used for mobile communication.

However, an output from antenna attached to a terminal equipment for mobile communication, such as a portable telephone, or the like is easily conducted to the signal cable of the earphone system due to electromagnetic coupling. As a result, electromagnetic wave is conducted to a head of the user through the signal cable. This sometimes increases localized SAR (absorbed electric power per specific weight) value.

Thus, electromagnetic waves produced from a terminal equipment for mobile communication or the like cause a problem in which an influence of the electromagnetic waves to a human body becomes serious.

Various researches have been made in recent years as regards such an influence of the electromagnetic waves to a human body. It is sure that the influence would become serious problem more and more from now on in accordance with further popularization of the mobile communication equipment. In addition, unnecessary high-frequency noise (current) is sometimes

conducted to a signal cable used for transmitting signals between devices or between components in various electronic information equipment. An erroneous operation of electronic information equipment is thereby caused to occur.

5           It is therefore an object of the present invention to provide a high-frequency current suppressor which is capable of being readily attached to a signal cable used for transmitting signals between devices or between components in various electronic information equipment and which can prevent the  
10 electronic information equipment from erroneous operations by reducing unnecessary high-frequency current conducted to the signal cable.

          It is another object of the present invention to provide a high-frequency current suppressor which is capable of being readily  
15 attached to an earphone, a signal cable, or the like, and which can prevent electromagnetic wave from increasing SAR value in a human head by reducing unnecessary high-frequency current generated in the signal cable due to induction of the electromagnetic wave produced from a terminal equipment, and the  
20 like, and also to provide an earphone system using the high-frequency current suppressor.

#### DISCLOSURE OF THE INVENTION:

          According to an aspect of the present invention, as  
25 described in claim 1, there is provided a high-frequency current suppressor comprising a flexible member capable of being attached to a cable.

          As described in claim 2, it is preferable that the flexible

member comprises a break, which elongates over all length along an axial direction of the cable.

As described in claim 3, the high-frequency current suppressor may comprise at least two layers which consist of a high-frequency current suppressing layer and at least one outer layer. As described in claim 4, the outer layer may be consisting of either a molded resin or a molded metal, or combination of the molded resin and the molded metal.

As described in claim 5, the high-frequency current suppressor may be consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including at least Fe, Si, Al, and binding material.

As described in claim 6, the high-frequency current suppressor may be consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including at least Ni, Fe, and binding material.

As described in claim 7, the high-frequency current suppressor may be consisting of magnetic loss thin film which comprises a first member consisting of at least any one of Fe, Co, Ni, or mixture thereof and a second member consisting of insulating material including at least more than one kinds of elements other than Fe, Co, Ni.

As described in claim 8, an earphone system for use in a terminal of mobile communication may be provided with the high-frequency current suppressor as claimed in any one of the claims 1 through 7.

Besides, "earphone system" depicted in the present invention includes not only a system having one earphone (for use

in a single ear) or two earphones (for use in both ears) but also another system having, what we call, a headphone combining two earphones (for use in both ears) and a head band etc..

According to another aspect of the present invention, as  
5 described in claim 9, there is provided an earphone system comprising a connection plug connected to an output terminal of an electronic equipment, an earphone, and a signal cable for connecting the connection plug with the earphone, wherein a high-frequency current suppressor consisting of soft magnetic material  
10 is added at least partially to any one of the connection plug, the earphone, and the signal cable.

As described in claim 10, a part or a whole of outer circumference of the signal cable may be covered by the high-frequency current suppressor.

15 As described in claim 11, a part or a whole of outer circumference of an outer conductor of the signal cable may be covered by the high-frequency current suppressor.

As described in claim 12, the high-frequency current suppressor may be provided near a portion where the signal cable  
20 and the earphone are connected to each other.

As described in claim 13, the high-frequency current suppressor may be included inside the earphone.

As described in claim 14, the earphone system may further comprise a microphone.

25 As described in claim 15, the high-frequency current suppressor may be included inside the microphone.

As described in claim 16, a housing of the earphone or the microphone may be formed by the high-frequency current

suppressor.

As described in claim 17, the high-frequency current suppressor may be consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including at least Fe, Si, Al, and binding material.

As described in claim 18, the high-frequency current suppressor may be consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including at least Ni, Fe, and binding material.

As described in claim 19, the high-frequency current suppressor may be consisting of magnetic loss thin film which comprises a first member consisting of at least any one of Fe, Co, Ni, or mixture thereof and a second member consisting of insulating material including at least more than one kinds of elements other than Fe, Co, Ni.

#### BRIEF DESCRIPTION OF THE DRAWINGS:

Fig. 1 is an explanation view for showing a high-frequency current suppressor according to a first embodiment of the present invention, (a) is a schematic perspective view showing the high-frequency current suppressor, (b) is a schematic perspective view showing a condition in which the high-frequency current suppressor is attached to a cable;

Fig. 2 is a schematic perspective view for showing a high-frequency current suppressor according to a second embodiment of the present invention;

Fig. 3 is a schematic perspective view for showing a high-frequency current suppressor according to a third embodiment

of the present invention;

Fig. 4 is a schematic perspective view for showing a high-frequency current suppressor according to a fourth embodiment of the present invention;

5 Fig. 5 is a view for showing suppressing effects against high-frequency electromagnetic waves in the high-frequency current suppressor according to the first through the fourth embodiments of the present invention;

10 Fig. 6 is an explanation view for showing an earphone system according to a fifth embodiment of the present invention, (a) is a schematic perspective view showing the earphone system, (b) is an enlarged view showing a high-frequency current suppressor thereof;

15 Fig. 7 is an explanation view for showing an earphone system according to a sixth embodiment of the present invention, (a) is a schematic perspective view showing the earphone system, (b) is an enlarged view showing a high-frequency current suppressor thereof;

20 Fig. 8 is an explanation view for showing an earphone system according to a seventh embodiment of the present invention, (a) is a schematic perspective view showing the earphone system, (b) is an enlarged view showing a high-frequency current suppressor thereof;

25 Fig. 9 is an explanation view for showing an earphone system according to an eighth embodiment of the present invention, (a) is a schematic perspective view showing the earphone system, (b) is an enlarged sectional view showing an earphone thereof;

Fig. 10 is an enlarged sectional view for showing a

microphone of an earphone system according to an ninth embodiment of the present invention;

Fig. 11 is an enlarged view for showing an earphone of an earphone system according to a tenth embodiment of the present invention;

Fig. 12 is an enlarged view for showing a microphone of an earphone system according to an eleventh embodiment of the present invention; and

Fig. 13 is a view for showing measuring effects of suppressing effect against high-frequency electromagnetic waves in the earphone system using the high-frequency current suppressor according to the fifth through the ninth embodiments of the present invention.

#### BEST MODE FOR EMBODYING THE INVENTION:

##### (First Embodiment)

Referring to Figs. 1(a) and 1(b), description is, at first, made about a high-frequency current suppressor according to a first embodiment of the present invention.

In Fig. 1(a), a high-frequency current suppressor 101 is essentially consisting of a composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including Fe, Si, Al, and a binding material. The composite magnetic material is subjected to press molding to have a cylindrical shape having a size of 1.5 mm in inner diameter, 2.65 mm in outer diameter, and 10.0 mm in length. The composite magnetic material has a break 113 which elongates length direction of the cylindrical shape in a part thereof. The composite magnetic material is thereby formed to have flexibility.

On the other hand, Fig. 1(b) shows a condition in which the high-frequency current suppressor 101 consisting of this composite magnetic material is attached to a signal cable 112 having a size of approximately 1.5 mm in outer diameter. The high-frequency current suppressor 101 has flexibility, as mentioned above. Let the break 113 of the high-frequency current suppressor 101 be opened by a hand or fingers to be attached to the signal cable 112 and release the high-frequency current suppressor 101 from the hand or fingers. Accordingly, the high-frequency current suppressor 101 is adhered and fixed to the signal cable 112.

In the interim, suppressing effects against high-frequency current was investigated as regards the high-frequency current suppressor 101 according to this embodiment, after the high-frequency current suppressor 101 was fixed to the signal cable 112. As a result, a suppressing effect of -17dB is obtained at such a frequency band of 900 MHz as used for mobile communication while another suppressing effect of -27dB is obtained at such a frequency band of 1.9 GHz as also used therefor.

In the first embodiment, the high-frequency current suppressor 101 is consisting of the composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including Fe, Si, and Al, and a binding material. However, the alloy powder is not required to include all of Fe, Si, and Al. The alloy powder is required to include at least any one of Fe, Si, Al.

#### (Second Embodiment)

Next, referring to Fig. 2, description will proceed to a high-frequency current suppressor according to a second

embodiment of the present invention.

In Fig. 2, a high-frequency current suppressor 102 comprises two layers which consist of a high-frequency current suppressing layer 121 and a resin outer layer 122. The high-frequency current suppressing layer 121 is essentially consisting of a composite magnetic material to have flexibility, similar to that of the first embodiment. An outer circumference of the high-frequency current suppressing layer 121 is covered by the resin outer layer 122 consisting of molded resin having a thickness of approximately 0.5 mm to have flexibility.

Also in the high-frequency current suppressor 102, similarly to the first embodiment, both the high-frequency current suppressing layer 121 and the resin outer layer 122 have flexibility. Let the break 123 of the high-frequency current suppressor 102 be opened by a hand or fingers to be attached to the signal cable 112(See Fig. 1) and release the high-frequency current suppressor 102 from the hand or fingers. Accordingly, the high-frequency current suppressor 102 is adhered and fixed to the signal cable 112(See Fig. 1).

Further, suppressing effects against high-frequency current was investigated as regards the high-frequency current suppressor 102, after being fixed to the signal cable 112(See Fig. 1). As a result, a suppressing effect of -18dB is obtained at such a frequency band of 900 MHz as used for mobile communication while another suppressing effect of -29dB is obtained at such a frequency band of 1.9 GHz as also used therefor.

(Third Embodiment)

Continuously, referring to Fig. 3, description proceeds to

a high-frequency current suppressor according to a third embodiment of the present invention.

In Fig. 3, a high-frequency current suppressor 103 comprises two layers which consist of a high-frequency current suppressing layer 131 and an aluminum outer layer 132. The  
5 high-frequency current suppressing layer 131 is essentially consisting of a composite magnetic material to have flexibility, similar to that of the first embodiment. An outer circumference of the high-frequency current suppressing layer 131 is covered by the  
10 aluminum outer layer 132 consisting of molded aluminum having a thickness of approximately 0.3 mm to have flexibility.

Also in the high-frequency current suppressor 103, similarly to the second embodiment, both the high-frequency current suppressing layer 131 and the aluminum outer layer 132  
15 have flexibility. Let the break 133 of the high-frequency current suppressor 103 be opened by a hand or fingers to be attached to the signal cable 112(See Fig. 1) and release the high-frequency current suppressor 103 from the hand or fingers. Accordingly, the high-frequency current suppressor 103 is adhered and fixed to the signal  
20 cable 112(See Fig. 1).

Further, suppressing effects against high-frequency current was investigated as regards the high-frequency current suppressor 103, after being fixed to the signal cable 112(See Fig. 1). As a result, a suppressing effect of -17dB is obtained at such a  
25 frequency band of 900 MHz as used for mobile communication while another suppressing effect of -32dB is obtained at such a frequency band of 1.9 GHz as also used therefor.

As described above, the outer layer 122 is consisting of

molded resin in the second embodiment while the outer layer 132 is consisting of molded metal (aluminum) in the third embodiment. However, the outer layer can be consisting of combination of both resin and metal.

5 (Fourth Embodiment)

Further, referring to Fig. 4, description proceeds to a high-frequency current suppressor according to a fourth embodiment of the present invention.

In Fig. 4, a high-frequency current suppressor 104 has  
10 three-layers structure which comprises a high-frequency current suppressing layer 141, a polyimide base material 142 and a resin outer layer 144. The high-frequency current suppressing layer 141 has flexibility and is consisting of magnetic loss thin film (granular magnetic thin film) composed of  $\text{Fe}_{72}\text{Al}_{11}\text{O}_{17}$ . The  
15 polyimide base material 142 has a thickness of approximately 0.2 mm to have flexibility. The resin outer layer 144 is consisting of molded resin having a thickness of approximately 0.5 mm to have flexibility. In order to fabricate these three-layers structure, at first, the high-frequency current suppressing layer 141 is formed on  
20 a surface of the polyimide base material 142 by sputtering to have a film thickness of 1.5  $\mu\text{m}$ . Thereby, the high-frequency current suppressing layer 141 and the polyimide base material 142 are formed to have a cylindrical shape having approximately 1.5 mm in inner diameter, and approximately 10.0 mm in length. An outer  
25 circumference of the high-frequency current suppressing layer 141 is then covered by the resin outer layer 144 consisting of molded resin having a thickness of approximately 0.5 mm to have flexibility.

Also in the high-frequency current suppressor 104, similarly to the second and the third embodiments, all of the high-frequency current suppressing layer 141, the polyimide base material 142 and the resin outer layer 144 have flexibility. Let  
5 the break 143 of the high-frequency current suppressor 104 be opened by a hand or fingers to be attached to the signal cable 112(See Fig. 1) and release the high-frequency current suppressor 104 from the hand or fingers. Accordingly, the high-frequency current suppressor 104 is adhered and fixed to the signal cable  
10 112(See Fig. 1).

Further, suppressing effects against high-frequency current was investigated as regards the high-frequency current suppressor 104, after being fixed to the signal cable 112(See Fig. 1). As a result, a suppressing effect of -23dB is obtained at such a  
15 frequency band of 900 MHz as used for mobile communication while another suppressing effect of -35dB is obtained at such a frequency band of 1.9 GHz as also used therefor.

Herein, Fig. 5 shows suppressing effects against high-frequency electromagnetic waves in the high-frequency current suppressors according to the first through the fourth embodiments.  
20

In Fig. 5, EXAMPLE 1 shows measuring effects of transmission characteristics by a network analyzer between two ports. In these measuring, the high-frequency current suppressors 101, 102 and 103 according to the first through the  
25 third embodiments are attached to be fixed to a central portion in the length direction of the cable having 1.5 mm in outer diameter and 300 mm in length. Then, both ends of the cable are connected to the network analyzer, as the above-mentioned two ports.

On the other hand, EXAMPLE 2 shows measuring effect of transmission characteristics by a network analyzer between two ports. In this measuring, the high-frequency current suppressor 104 according to the fourth embodiment is attached to be fixed to the central portion of the cable, and then both ends of the cable are connected to the network analyzer, similarly to the EXAMPLE 1.

As will be understood from Fig. 5, according to EXAMPLE 1 and EXAMPLE 2, suppressing effects between 25dB and 35dB can be obtained at quasi-microwave band in any high-frequency current suppressors 101, 102, 103 and 104.

Besides, other than the high-frequency current suppressors 101, 102, 103 and 104, alternative high-frequency current suppressors can be designed by changing material composition or size thereof. Accordingly, desirable suppressing characteristics can be obtained by adapting the material composition or the size of the high-frequency current suppressors to a cable.

Further, other than the high-frequency current suppressors according to the above-mentioned first through fourth embodiments, it will now be readily possible to put this invention into effect in various other manners. For example, a break 113, 123, 133 or 143 was formed to be a substantially straight line parallel to an axis of the cylindrical shape of the high-frequency current suppressors. The break can be formed to have an angle to the axis of the cylindrical shape. In addition, the break can be formed as a curve. Alternatively, the break can be composed of two edges interfitted to each other when the break is closed. In addition, shapes of the high-frequency current suppressors are not

limited to the cylindrical shape. The high-frequency current suppressors can be formed to have a rectangular shape. Further, a member for preventing the cable from slipping or an adhesive layer can be provided at inner side of the cylindrical or the rectangular tube.

As described above, according to the first through the fourth embodiments of the present invention, the high-frequency current suppressors 101, 102, 103 or 104 comprises a flexible member capable of being attached to a cable. Furthermore, the flexible member comprises a break which elongates over all length along an axial direction of the cable. The high-frequency current suppressors 101, 102, 103 or 104 can therefore be readily attached and fixed to a signal cable used for an earphone, a microphone, and the other electronic equipments. Excellent suppressing effects can be obtained at quasi-microwave band in any high-frequency current suppressors 101, 102, 103 and 104. Accordingly, it is possible to provide a high-frequency current suppressor which can suppress unnecessary high-frequency current sufficiently and which is thereby effective to solve various EMI (electromagnetic interference) problems. It is also possible to prevent electromagnetic waves from increasing SAR value in a human head by applying the high-frequency current suppressor 101, 102, 103 or 104 to earphone, headphone or a signal cable connecting those to a terminal equipment for mobile communication.

Next, referring to drawings, description will proceed to an earphone system according to a fifth through an eleventh embodiments of the present invention.

(Fifth Embodiment)

Referring to Figs. 6(a) and 6(b), description is, at first, made about an earphone system according to a fifth embodiment of the present invention.

As illustrated in Fig. 6(a), an earphone system 201  
5 comprises an earphone 211, a microphone 212, a connection plug 213, and a signal cable 214 for connecting the earphone 211 and the microphone 212 as well as the microphone 212 and the connection plug 213. The signal cable 214 comprises unillustrated an inner conductor, an outer conductor and insulation coating over those  
10 inner conductor and outer conductor. Further, as illustrated in Fig. 6(b), the signal cable 214 is overlaid by a cable housing 216 over all of the length thereof. Further, the earphone system 201 comprises a high-frequency current suppressor 215 attached to the signal cable 214 at a position near the earphone 211 with covering  
15 an external circumferencial surface 216a of the cable housing 216 at the position.

The high-frequency current suppressor 215 is formed to have a hollow cylindrical shape having a size of 1.55 mm in inner diameter, 2.20 mm in outer diameter, and 10.0 mm in length, as  
20 illustrated in Fig. 6(b). As illustrated in Figs. 6(a) and 6(b), the high-frequency current suppressor 215 is fixed to the signal cable 214 at the position near the earphone 211 with an internal circumference thereof being adhered to an external circumferencial surface 216a of the cable housing 216.

25 Herein, the high-frequency current suppressor 215 is consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including Fe, Si, Al, and binding material. The high-frequency current

suppressor 215 is formed by press molding to have the above-mentioned hollow cylindrical shape and the size.

(Sixth Embodiment)

Referring to Figs. 7(a) and 7(b), description will proceed  
5 to an earphone system according to a sixth embodiment of the present invention. The earphone system according to the sixth embodiment has a structure basically similar to that of the fifth embodiment illustrated in Figs. 6(a) and 6(b). Similar portions are therefore designated by like reference numerals and detailed  
10 description thereof is omitted accordingly.

As illustrated in Fig. 7(a), an earphone system 202 comprises a high frequency current suppressor 225 attached to an end of the earphone 211 in series. The high-frequency current suppressor 225 is formed to have a hollow taper shape having a size  
15 of 1.55 mm in inner diameter, 3.30 mm in outer diameter of the upper portions, 2.0 mm in outer diameter of the lowest portions, and 5.5 mm in length of the taper portion, as illustrated in Fig. 7(b). As illustrated in Figs. 7(a) and 7(b), the high-frequency current suppressor 225 is fixed to the end of the earphone 211 in series with  
20 an internal circumference thereof being adhered to an external circumferential surface 216a of the cable housing 216 of the signal cable 214.

Besides, the high-frequency current suppressor 225 is consisting of composite magnetic material which comprises soft  
25 magnetic powder obtained by flattening alloy powder including Fe, Si, Al, and binding material, similarly to the high-frequency current suppressor 215 according to the fifth embodiment. The high-frequency current suppressor 225 is formed by press molding

to have the above-mentioned hollow taper shape and the size.

(Seventh Embodiment)

Continuously, referring to Figs. 8(a) and 8(b), description will proceed to an earphone system according to a seventh embodiment of the present invention. The earphone system according to the seventh embodiment has a structure basically similar to that of the fifth embodiment illustrated in Figs. 6(a) and 6(b). Similar portions are therefore designated by like reference numerals and detailed description thereof is omitted accordingly.

As illustrated in Fig. 8(a), an earphone system 203 according to the seventh embodiment comprises a high-frequency current suppressor 235 attached to the signal cable 234 at a position near the earphone 211, similarly to that of the above-mentioned fifth embodiment. The signal cable 234 is, what we call, a coaxial cable. The signal cable 234 comprises unillustrated an inner conductor, an outer conductor, an insulation coating layer for insulating the inner conductor from the outer conductor, and an insulation cable housing for coating the outer conductor substantially all over the length thereof [only the insulation cable housing is shown by a reference numeral 234d in Fig. 8(b)]. In this earphone system 203 according to the seventh embodiment, the signal cable 234 includes a portion lacking of the insulation cable housing 234d near the earphone 211, as illustrated in Figs. 8(a) and 8(b). The high-frequency current suppressor 235 is formed on an exposed surface of the outer conductor in this portion.

Herein, the high-frequency current suppressor 235 is consisting of magnetic loss thin film (granular magnetic thin film) composed of  $\text{Fe}_{72}\text{Al}_{11}\text{O}_{17}$ . The high-frequency current suppressor

235 is formed to have a length of 5.5 mm and a film thickness of 1.5  $\mu$ m on a surface of the outer conductor 234b.

(Eighth Embodiment)

Further, referring to Figs. 9(a) and 9(b), description will  
5 proceed to an earphone system according to a eighth embodiment of  
the present invention. As illustrated in Fig. 9(a), the earphone  
system 204 according to the eighth embodiment comprises an  
earphone 241, a microphone 242, a connection plug 213, and a  
signal cable 244 for connecting the earphone 241 and the  
10 microphone 242 as well as the microphone 242 and the connection  
plug 213. As illustrated in Fig. 9(b), the earphone 241 comprises a  
speaker portion 248. Similarly to the signal cable 234 of the  
above-mentioned seventh embodiment, the signal cable 244  
comprises unillustrated an inner conductor, an outer conductor, an  
15 insulation coating layer for insulating the inner conductor from the  
outer conductor, and an insulation cable housing for coating the  
outer conductor substantially all over the length thereof [only the  
outer conductor 244b and the insulation cable housing 244d are  
shown in Fig. 9(b)]. Within the earphone 241, the inner conductor  
20 and the outer conductor 244b are connected to the speaker portion  
248, respectively.

In this earphone system 204 according to the eighth  
embodiment, as illustrated in Fig. 9(a), no high-frequency current  
suppressor is attached to a portion near the earphone 241 or an end  
25 of the earphone 241. As illustrated in Fig. 9(b), a high-frequency  
current suppressor 245 is formed on a surface of the outer  
conductor 244b, in other words, between the outer conductor 244b  
and the insulation cable housing 244d.

Further, the high-frequency current suppressor 245 is consisting of magnetic loss thin film (granular magnetic thin film) composed of  $\text{Fe}_{72}\text{Al}_{11}\text{O}_{17}$ . The high-frequency current suppressor 245 is formed to have a length of 4.2 mm and a film thickness of 1.9  $\mu\text{m}$  on the surface of the outer conductor 244b.

(Ninth Embodiment)

Further, referring to Fig. 10, description will proceed to an earphone system according to an ninth embodiment of the present invention.

The earphone system 205 according to the ninth embodiment has a basic structure similar to that of the eighth embodiment illustrated in Fig. 9(a). Illustration of the basic structure is omitted, but reference numerals of only different portions are designated by parentheses in Fig. 9(a). Namely, as illustrated in Fig. 9(a), the earphone system 205 according to the ninth embodiment comprises an earphone 241, a microphone 252, a connection plug 213, and a signal cable 244 for connecting the earphone 241 and the microphone 252 as well as the microphone 252 and the connection plug 213. As illustrated in Fig. 10, the microphone 252 comprises a microphone portion 259. Within the microphone 252, the inner conductor and the outer conductor 244b are connected to the microphone portion 259, respectively.

In this earphone system 205 according to the ninth embodiment, as illustrated in Fig. 9(a), no high-frequency current suppressor is attached to a portion near the earphone 241 or an end of the earphone 241. As illustrated in Fig. 10, a high-frequency current suppressor 255 is formed on a surface of the outer conductor 244b, in other words, between the outer conductor 244b

and the insulation cable housing 244d.

Further, the high-frequency current suppressor 255 is consisting of magnetic loss thin film (granular magnetic thin film) composed of  $\text{Fe}_{72}\text{Al}_{11}\text{O}_{17}$ . The high-frequency current suppressor  
5 255 is formed to have a length of 4.2 mm and a film thickness of 1.9  $\mu\text{m}$  on the surface of the outer conductor 244b.

(Tenth Embodiment)

Further, referring to Fig. 11, description will proceed to an earphone system according to a tenth embodiment of the present  
10 invention.

The earphone system 206 according to the tenth embodiment has a basic structure similar to the earphone system 204 of the eighth embodiment illustrated in Fig. 9(a). Illustration of the basic structure is omitted, but reference numerals of only  
15 different portions are designated by parentheses in Fig. 9(a). Namely, as illustrated in Fig. 9(a), the earphone system 206 according to the tenth embodiment comprises an earphone 261, a microphone 212, a connection plug 213, and a signal cable 244 for connecting the earphone 261 and the microphone 212 as well as the  
20 microphone 212 and the connection plug 213.

In this earphone system 206 according to the tenth embodiment, as illustrated in Fig. 9(a), no high-frequency current suppressor is attached to a portion near the earphone 261 or an end of the earphone 261. As illustrated in Fig. 11, a high-frequency  
25 current suppressor itself is used as a molded resin constructing a case of the earphone 261.

Herein, the high-frequency current suppressor 265 is consisting of a resin including composite magnetic material which

comprises soft magnetic powder obtained by flattening alloy powder including Fe, Si, Al, and binding material. The high-frequency current suppressor 265 is formed by press molding to have a structure illustrated in Fig. 11.

5 (Eleventh Embodiment)

Further, referring to Fig. 12, description will proceed to an earphone system according to an eleventh embodiment of the present invention.

The earphone system 207 according to the eleventh  
10 embodiment has a basic structure similar to the earphone system 204 of the eighth embodiment illustrated in Fig. 9(a). Illustration of the basic structure is omitted, but reference numerals of only different portions are designated by parentheses in Fig. 9(a). Namely, as illustrated in Fig. 9(a), the earphone system 207  
15 according to the eleventh embodiment comprises an earphone 241, a microphone 272, a connection plug 213, and a signal cable 244 for connecting the earphone 241 and the microphone 272 as well as the microphone 272 and the connection plug 213.

In this earphone system 207 according to the eleventh  
20 embodiment, as illustrated in Fig. 9(a), no high-frequency current suppressor is attached to a portion near the earphone 241 or an end of the earphone 241. As illustrated in Fig. 12, a high-frequency current suppressor itself is used as a molded resin constructing a case of the microphone 272.

25 Herein, the high-frequency current suppressor 275 is consisting of a resin including composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including Fe, Si, Al, and binding material. The high-frequency

current suppressor 275 is formed by press molding to have a structure illustrated in Fig. 12.

Hereinunder, description will proceed to operations and effects of the earphone system according to the fifth through the eleventh embodiments of the present invention. Fig. 13 shows measuring effects of suppressing effect against high-frequency electromagnetic waves in the earphone system using the high-frequency current suppressor according to the fifth through the eleventh embodiments.

10 In the measurement, at first, a tube having 2.5 mm in diameter and 15 mm in length, which has in its central a through hole having 0.5 mm in diameter is prepared. Next, a copper wire having 0.5 mm in diameter and 300 mm in length is penetrated through the through hole. The composite magnetic material is  
15 then attached to a central portion of the copper wire in the length direction thereof to obtain a primary line including a primary high-frequency current suppressor (depicted as "composite magnetic material" in Fig. 13). On the other hand, a granular magnetic thin film used in the seventh and the eighth embodiments  
20 is formed by sputtering on a external circumference of the above-mentioned copper line to have a length of 15 mm to obtain a secondary line including a secondary high-frequency current suppressor (depicted as "granular magnetic thin film" in Fig. 13). Both ends of the primary line including the primary high-frequency  
25 current suppressor are connected to a network analyzer to investigate transmission characteristics between two ports. Also both ends of the secondary line including the secondary high-frequency current suppressor are connected to the network

analyzer to investigate transmission characteristics between two ports.

As a result, suppressing effects between 20dB and 35dB can be obtained at quasi-microwave band in any of the primary and the secondary high-frequency current suppressors. Besides, other  
5 than the high-frequency current suppressors depicted in the above embodiments, larger suppressing effects can be obtained by changing material composition or size thereof.

As described above, according to the earphone system of  
10 the fifth through the eleventh embodiments of the present invention, a high-frequency current suppressor is added to an earphone or a microphone itself, alternatively, to a part of a signal cable for connecting the earphone or the microphone into a terminal equipment for mobile communication. High-frequency current  
15 generated in a signal cable by electromagnetic waves produced from the terminal equipment can be reduced. Therefore, it becomes possible to provide an earphone system which is able to prevent an increase of SAR value in a human head by the electromagnetic waves.

20 While this invention has thus far been described in specific conjunction with only several embodiments thereof, it will now be readily possible for one skilled in the art to put this invention into effect in various other manners. For example, in the above embodiments, an earphone system of the present  
25 invention was described as regards such an earphone system as used for a portable telephone. However, the earphone system of the present invention is not limited to such a use. The earphone system of the present invention can be applied to various electronic

equipments for enjoying music or movies, in which an earphone or a headphone is generally used.

#### INDUSTRIAL APPLICABILITY:

5           As described above, according to an aspect of the present invention, a high-frequency current suppressor can be readily attached and fixed to an earphone, a microphone, or a signal cable used for the other electronic equipments. Therefore, unnecessary high-frequency current can be reduced sufficiently. Accordingly,  
10   the present invention is effective enough to solve various EMI problems.

          Further, according to another aspect of the present invention, high-frequency current generated by electromagnetic induction can be reduced by adding a high-frequency current  
15   suppressor to at least, an earphone, a headphone or a microphone itself, alternatively, a part of a signal cable for connecting those. Accordingly, the present invention is very effective to the increase of SAR value in a human head by the electromagnetic waves that has been seriously a problem in recent years.

## CLAIMS

1. A high-frequency current suppressor comprising a flexible  
5 member capable of being attached to a cable.

2. A high-frequency current suppressor as claimed in claim 1,  
wherein said flexible member comprises a break which elongates  
over all length along an axial direction of said cable.

10

3. A high-frequency current suppressor as claimed in claim 1,  
wherein said high-frequency current suppressor comprises at least  
two layers which consist of a high-frequency current suppressing  
layer and at least one outer layer.

15

4. A high-frequency current suppressor as claimed in claim 3,  
wherein said outer layer is consisting of either a molded resin or a  
molded metal, or combination of said molded resin and said molded  
metal.

20

5. A high-frequency current suppressor as claimed in any one of  
claims 1 through 4, wherein said high-frequency current suppressor  
is consisting of composite magnetic material which comprises soft  
magnetic powder obtained by flattening alloy powder including at  
25 least Fe, Si, Al, and binding material.

6. A high-frequency current suppressor as claimed in any one of  
claims 1 through 4, wherein said high-frequency current suppressor

is consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including at least Ni, Fe, and binding material.

5 7. A high-frequency current suppressor as claimed in any one of claims 1 through 4, wherein said high-frequency current suppressor is consisting of magnetic loss thin film which comprises a first member consisting of at least any one of Fe, Co, Ni, or mixture thereof and a second member consisting of insulating material  
10 including at least more than one kinds of elements other than said Fe, Co, Ni.

8. An earphone system for use in a terminal of mobile communication, wherein said earphone system is provided with  
15 said high-frequency current suppressor as claimed in any one of claims 1 through 7.

9. An earphone system comprising a connection plug connected to an output terminal of an electronic equipment, an earphone, and a  
20 signal cable for connecting said connection plug with said earphone, wherein a high-frequency current suppressor consisting of soft magnetic material is added at least partially to any one of said connection plug, said earphone, and said signal cable.

25 10. An earphone system as claimed in claim 9, wherein a part or a whole of outer circumference of said signal cable is covered by said high-frequency current suppressor.

11. An earphone system as claimed in claim 9 or 10, wherein a part or a whole of outer circumference of an outer conductor of said signal cable is covered by said high-frequency current suppressor.

5 12. An earphone system as claimed in any one of claims 9 through 11, wherein said high-frequency current suppressor is provided near a portion where said signal cable and said earphone are connected to each other.

10 13. An earphone system as claimed in any one of claims 9 through 12, wherein said high-frequency current suppressor is included inside said earphone.

14. An earphone system as claimed in any one of claims 9 through  
15 13, wherein said earphone system further comprises a microphone.

15. An earphone system as claimed in claim 14, wherein said high-frequency current suppressor is included inside said microphone.

20

16. An earphone system as claimed in any one of claims 9 through 15, wherein a housing of said earphone or said microphone is formed by said high-frequency current suppressor.

25 17. An earphone system as claimed in any one of claims 9 through 16, wherein said high-frequency current suppressor is consisting of composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including at least Fe, Si, Al,

and binding material.

18. An earphone system as claimed in any one of claims 9 through 16, wherein said high-frequency current suppressor is consisting of  
5 composite magnetic material which comprises soft magnetic powder obtained by flattening alloy powder including at least Ni, Fe, and binding material.

19. An earphone system as claimed in any one of claims 9 through  
10 16, wherein said high-frequency current suppressor is consisting of magnetic loss thin film which comprises a first member consisting of at least any one of Fe, Co, Ni, or mixture thereof and a second member consisting of insulating material including at least more than one kinds of elements other than said Fe, Co, Ni.

1/9

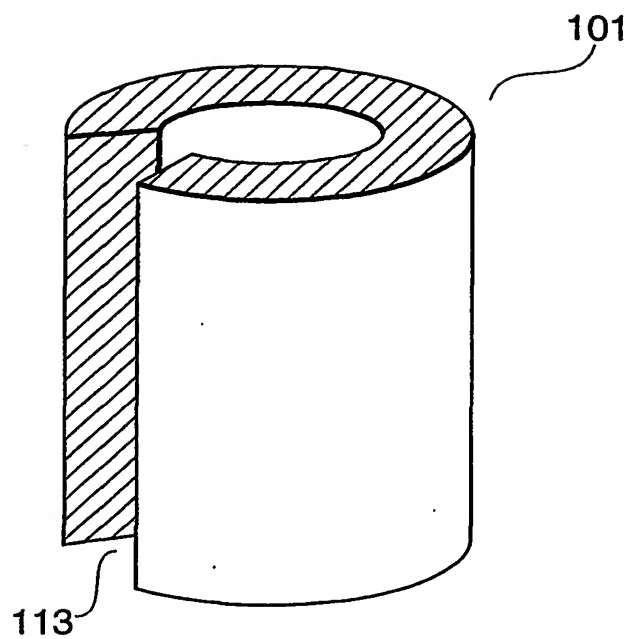


FIG. 1(a)

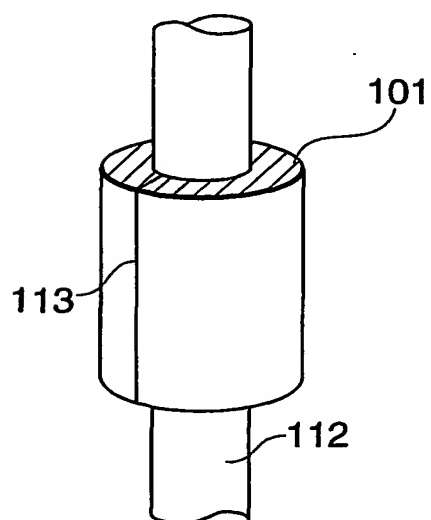


FIG. 1(b)

2/9

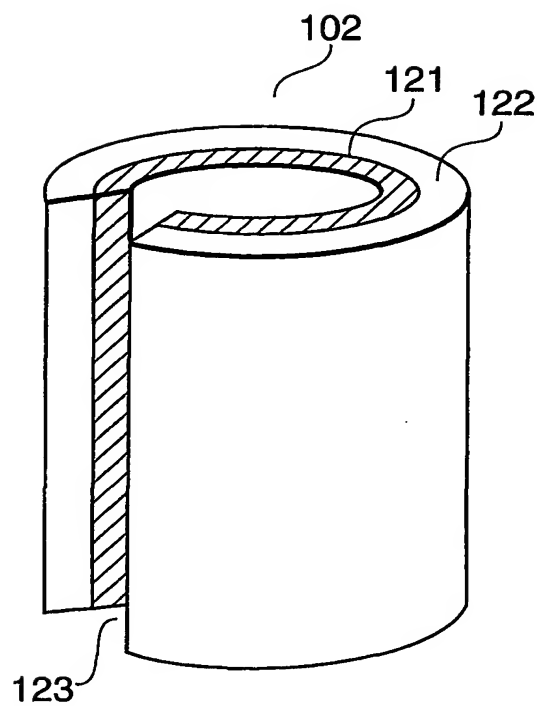


FIG.2

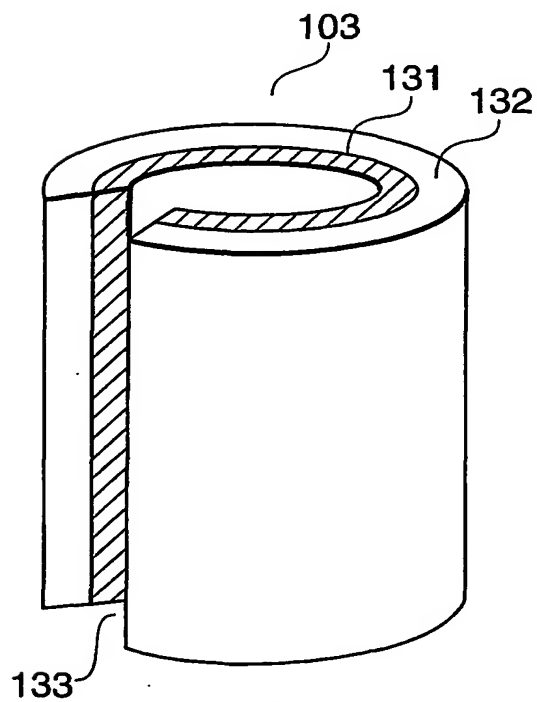


FIG.3

3/9

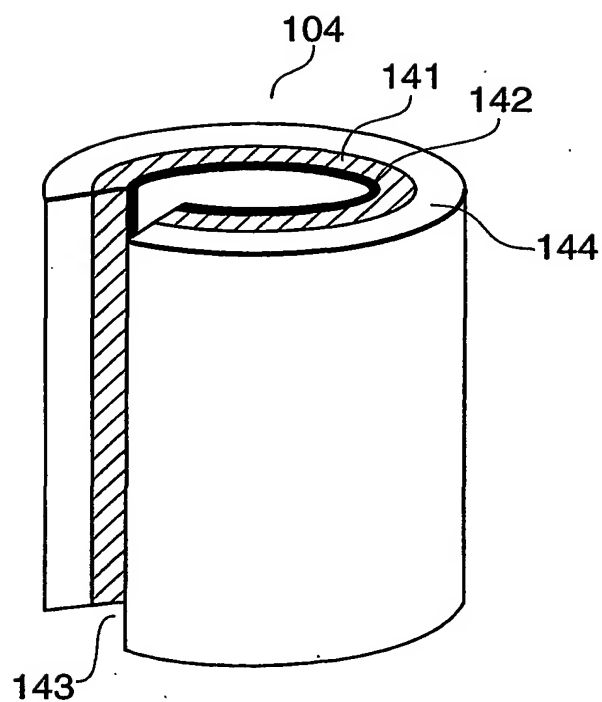


FIG.4

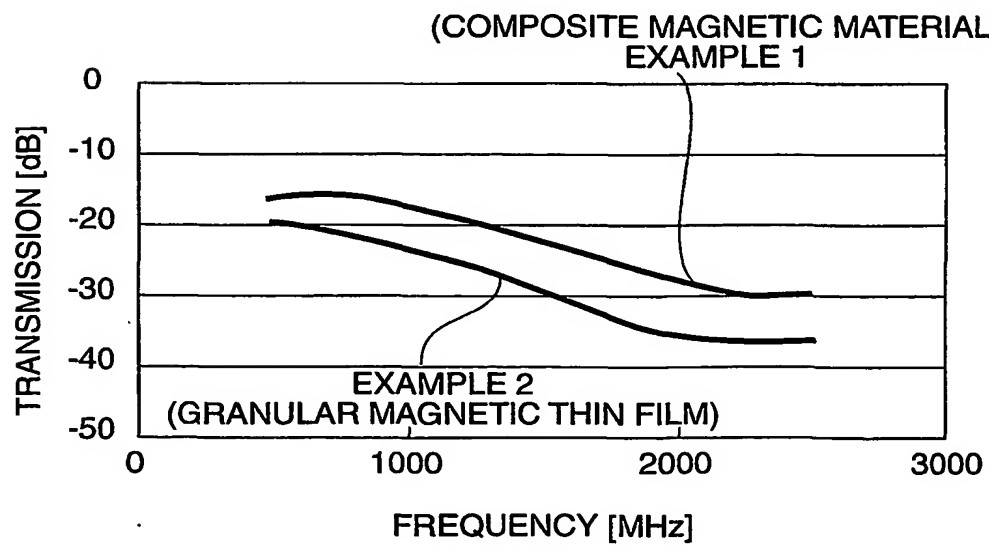


FIG.5

4/9

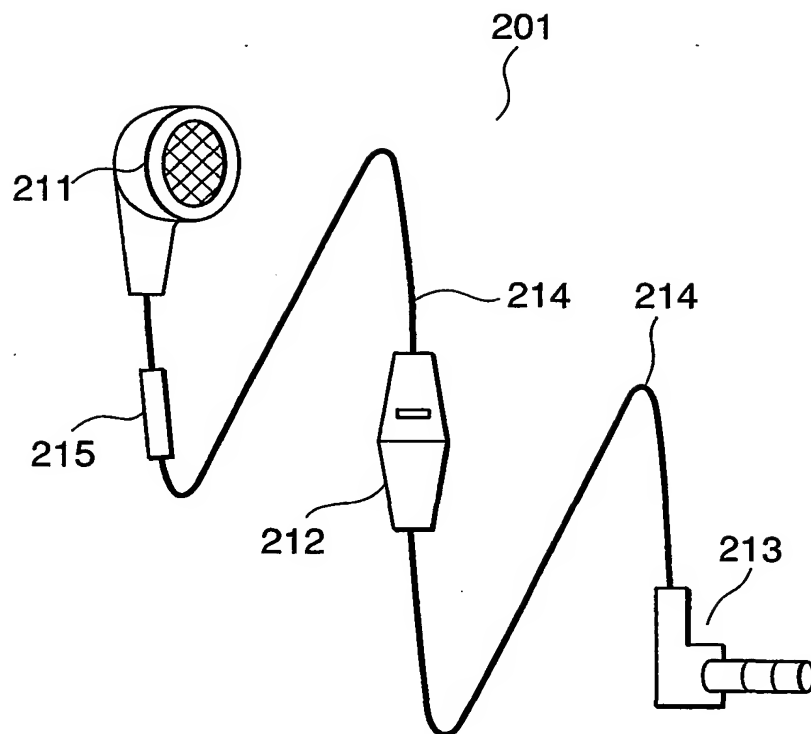


FIG. 6(a)

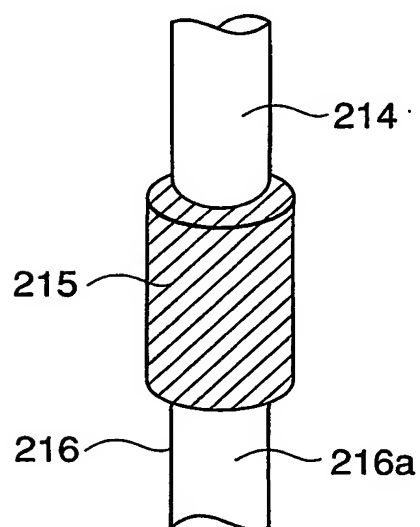


FIG. 6(b)

5/9

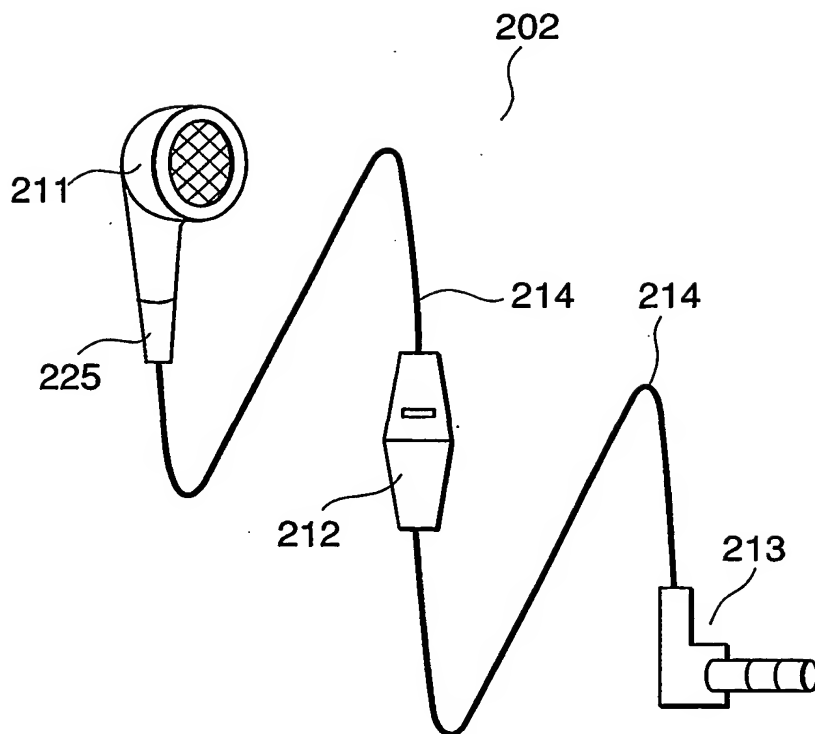


FIG. 7(a)

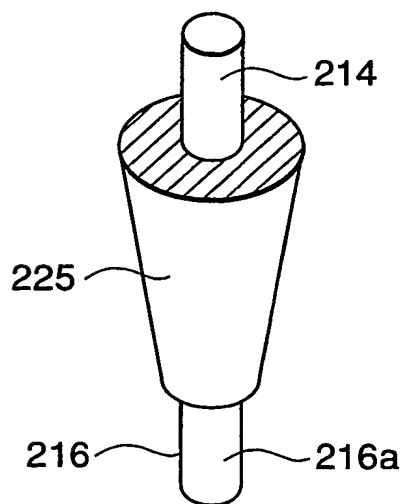


FIG. 7(b)

6/9

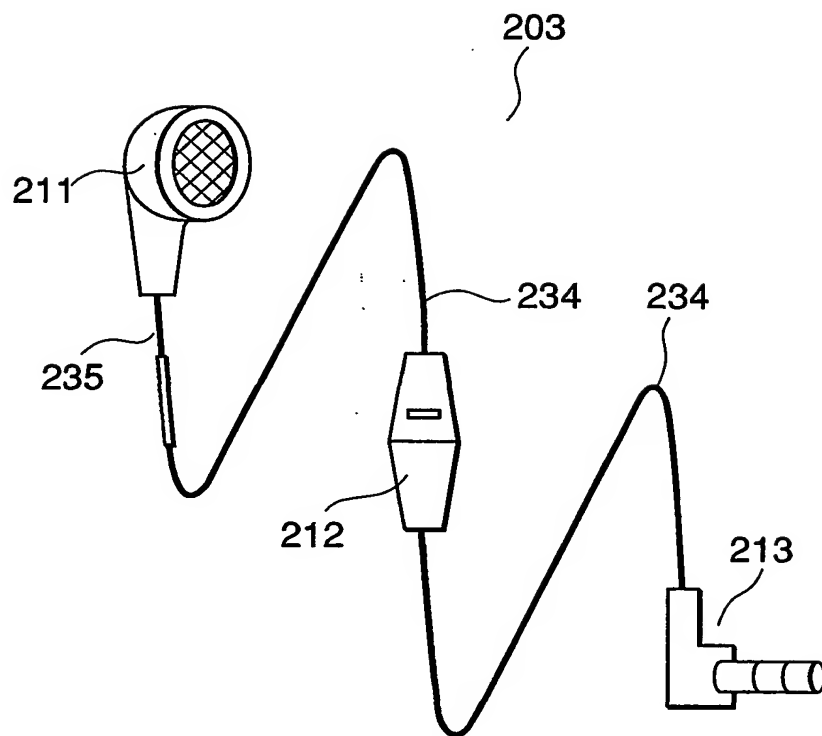


FIG. 8(a)

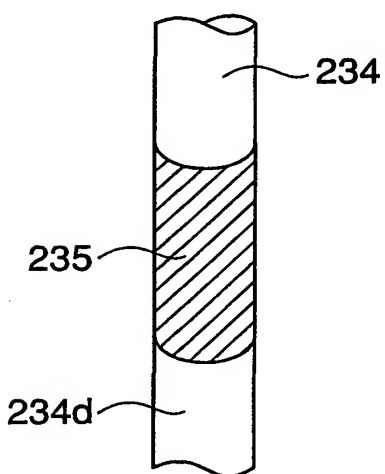


FIG. 8(b)

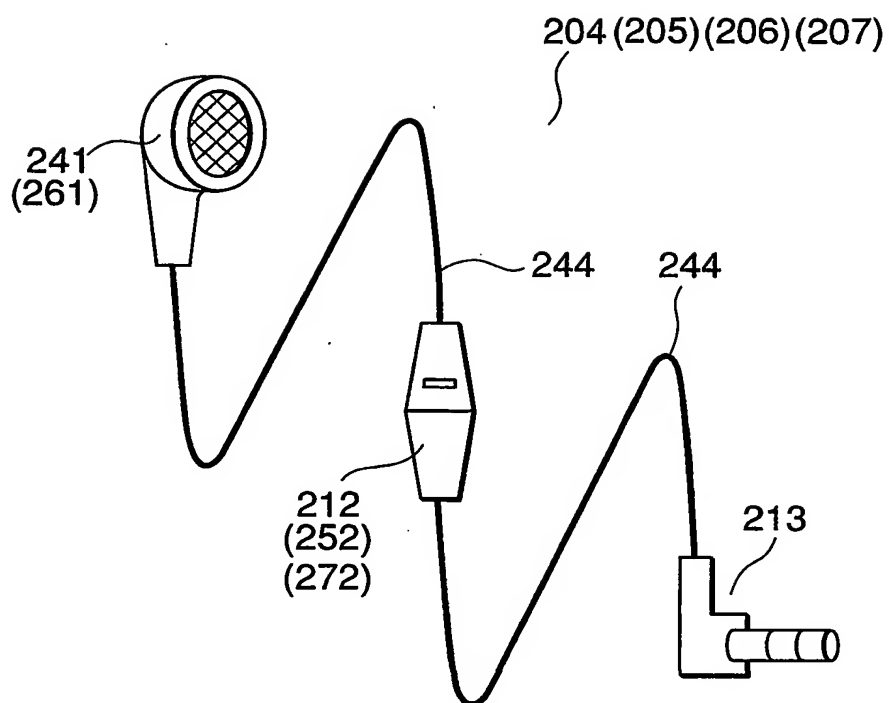


FIG. 9(a)

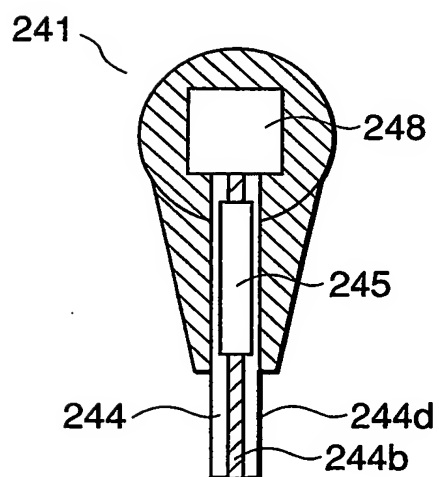


FIG. 9(b)

8/9

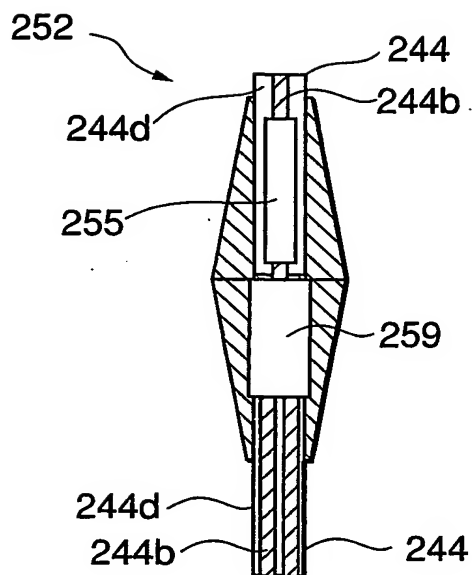


FIG.10

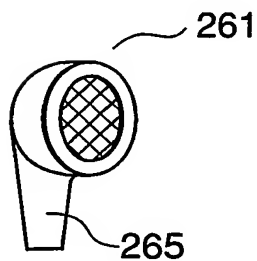


FIG.11

9/9

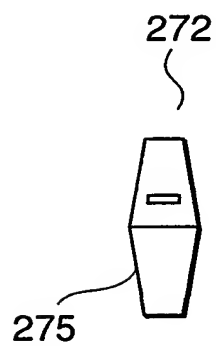


FIG.12

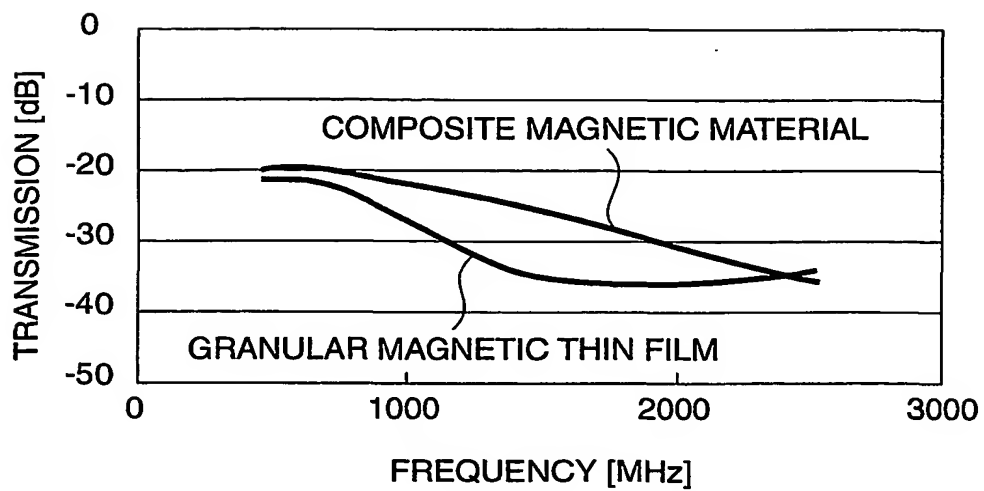


FIG.13

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
25 October 2001 (25.10.2001)

PCT

(10) International Publication Number  
**WO 01/80616 A3**

(51) International Patent Classification<sup>7</sup>: **H05K 9/00**,  
H04M 1/02, H04R 1/10

6-chome, Taihaku-ku, Sendai-shi, Miyagi 982-8510 (JP).  
**YOSHIDA, Shigeyoshi** [JP/JP]: c/o Tokin Corporation,  
7-1, Koriyama 6-chome, Taihaku-ku, Sendai-shi, Miyagi  
982-8510 (JP).

(21) International Application Number: PCT/JP01/03271

(22) International Filing Date: 17 April 2001 (17.04.2001)

(74) Agent: **KURIHARA, Kiyoshi**: Nishikan Toranomon  
Bldg. 4th fl., 22-13, Toranomon 1-chome, Minato-ku,  
Tokyo 105-0001 (JP).

(25) Filing Language: English

(26) Publication Language: English

(81) Designated States (*national*): CN, KR, NO, SG, US.

(30) Priority Data:  
2000-114912 17 April 2000 (17.04.2000) JP  
2000-127191 27 April 2000 (27.04.2000) JP

(84) Designated States (*regional*): European patent (DE, FI,  
FR, GB, SE).

(71) Applicant (*for all designated States except US*): **TOKIN  
CORPORATION** [JP/JP]: 7-1, Koriyama 6-chome, Tai-  
haku-ku, Sendai-shi, Miyagi 982-8510 (JP).

Published:  
— with international search report

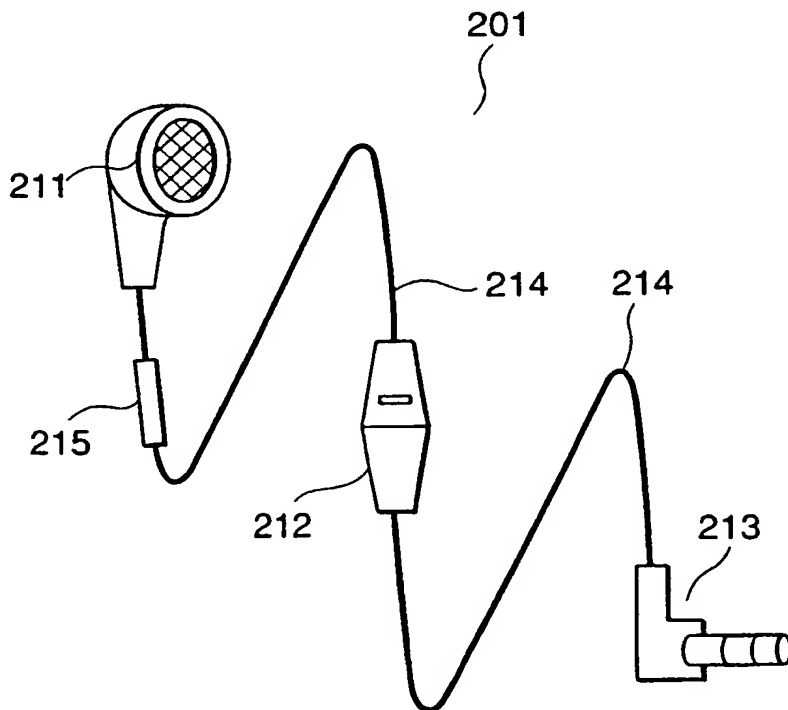
(88) Date of publication of the international search report:  
7 February 2002

(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **ONO, Hi-  
roshi** [JP/JP]: c/o Tokin Corporation, 7-1, Koriyama

*For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.*

(54) Title: HIGH-FREQUENCY CURRENT SUPPRESSOR CAPABLE OF BEING READILY ATTACHED TO CABLE OR THE  
LIKE AND EARPHONE SYSTEM USING THE SAME



(57) Abstract: An earphone system 201 comprises an earphone 211, a microphone 212, a connection plug 213, a signal cable 214 for connecting those, and a hollow cylindrical high-frequency current suppressor 215 attached to the signal cable 214 at a position near the earphone 211 with covering an external circumferential surface 216a of the cable housing 216. When used for a terminal equipment for mobile communication, high-frequency current generated by electromagnetic waves produced from the terminal equipment can be reduced. The earphone system 201 can prevent an increase of SAR value in human head.

WO 01/80616 A3

## INTERNATIONAL SEARCH REPORT

In Application No

PCT/JP 01/03271

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H05K9/00 H04M1/02 H04R1/10

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H05K H04R H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 199 09 569 A (MURATA MANUFACTURING CO) 16 September 1999 (1999-09-16) the whole document	1,3-7
Y	---	2
Y	---	8
Y	US 5 703 557 A (SAITO NORIO ET AL) 30 December 1997 (1997-12-30) the whole document	2
Y	---	
Y	FR 2 765 069 A (ELECTRICITE DE FRANCE) 24 December 1998 (1998-12-24) claims 1,6; figure 2Y	8
A	US 4 742 887 A (YAMAGISHI MAKOTO) 10 May 1988 (1988-05-10) the whole document	8
	---	
	-/--	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents:

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

\*8\* document member of the same patent family

Date of the actual completion of the international search

1 November 2001

Date of mailing of the international search report

08/11/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Toussaint, F

## INTERNATIONAL SEARCH REPORT

Inventor's Application No.

PCT/JP 01/03271

## C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>PATENT ABSTRACTS OF JAPAN vol. 1999, no. 09, 30 July 1999 (1999-07-30) &amp; JP 11 097246 A (TOKIN CORP), 9 April 1999 (1999-04-09) abstract</p> <p>-----</p>	1

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Inventor's Application No

PCT/JP 01/03271

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 19909569	A	16-09-1999	JP 11260160 A	24-09-1999
			DE 19909569 A1	16-09-1999
			US 6143406 A	07-11-2000
US 5703557	A	30-12-1997	JP 7122433 A	12-05-1995
			CN 1112381 A ,B	22-11-1995
			EP 0660342 A1	28-06-1995
			WO 9502253 A1	19-01-1995
			SG 47449 A1	17-04-1998
FR 2765069	A	24-12-1998	FR 2765069 A1	24-12-1998
			AU 5056698 A	04-01-1999
			EP 0992182 A1	12-04-2000
			WO 9859531 A1	30-12-1998
			TW 408556 B	11-10-2000
US 4742887	A	10-05-1988	DE 3706481 A1	03-09-1987
			DE 8703084 U1	01-10-1987
			FR 2595178 A1	04-09-1987
			GB 2187361 A ,B	03-09-1987
			HK 11991 A	22-02-1991
			KR 9207601 Y1	16-10-1992
JP 11097246	A	09-04-1999	NONE	

1/3



## PCT REQUEST

TNG-6-PCT

Original (for SUBMISSION) - printed on 17.04.2001 10:12:49 AM

0	<b>For receiving Office use only</b>	
0-1	International Application No.	
0-2	International Filing Date	
0-3	Name of receiving Office and "PCT International Application"	

**PCT**  
 17.4.01  
 受領印

0-4	<b>Form - PCT/RO/101 PCT Request</b>	
0-4-1	Prepared using	PCT-EASY Version 2.91 (updated 01.01.2001)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	Japanese Patent Office (RO/JP)
0-7	Applicant's or agent's file reference	TNG-6-PCT
I	Title of invention	HIGH-FREQUENCY CURRENT SUPPRESSOR CAPABLE OF BEING READILY ATTACHED TO CABLE OR THE LIKE AND EARPHONE SYSTEM USING THE SAME
II	Applicant	
II-1	This person is:	applicant only
II-2	Applicant for	all designated States except US
II-4	Name	TOKIN CORPORATION
II-5	Address:	7-1, Koriyama 6-chome, Taihaku-ku Sendai-shi, Miyagi 982-8510 Japan
II-6	State of nationality	JP
II-7	State of residence	JP
III-1	Applicant and/or inventor	
III-1-1	This person is:	applicant and inventor
III-1-2	Applicant for	US only
III-1-4	Name (LAST, First)	ONO, Hiroshi
III-1-5	Address:	c/o Tokin Corporation 7-1, Koriyama 6-chome, Taihaku-ku Sendai-shi, Miyagi 982-8510 Japan
III-1-6	State of nationality	JP
III-1-7	State of residence	JP

2/3

## PCT REQUEST

TNG-6-PCT

Original (for SUBMISSION) - printed on 17.04.2001 10:12:49 AM

<b>III-2</b>	<b>Applicant and/or inventor</b>	
III-2-1	This person is:	applicant and inventor
III-2-2	Applicant for	US only
III-2-4	Name (LAST, First)	YOSHIDA, Shigeyoshi
III-2-5	Address:	c/o Tokin Corporation 7-1, Koriyama 6-chome, Taihaku-ku Sendai-shi, Miyagi 982-8510 Japan
III-2-6	State of nationality	JP
III-2-7	State of residence	JP
<b>IV-1</b>	<b>Agent or common representative; or address for correspondence</b>	
	The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name (LAST, First)	KURIHARA, Kiyoshi
IV-1-2	Address:	Nishikan Toranomom Bldg.4th fl., 22-13, Toranomom 1-chome Minato-ku, Tokyo 105-0001 Japan
<b>V</b>	<b>Designation of States</b>	
<b>V-1</b>	<b>Regional Patent</b> (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	EP: DE FI FR GB SE and any other State which is a Contracting State of the European Patent Convention and of the PCT (except AT BE CH&LI CY DK ES GR IE IT LU MC NL PT TR)
<b>V-2</b>	<b>National Patent</b> (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	CN KR NO SG US
<b>V-5</b>	<b>Precautionary Designation Statement</b>  In addition to the designations made under Items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.	
<b>V-6</b>	<b>Exclusion(s) from precautionary designations</b>	NONE
<b>VI-1</b>	<b>Priority claim of earlier national application</b>	
VI-1-1	Filing date	17 April 2000 (17.04.2000)
VI-1-2	Number	P2000-114912
VI-1-3	Country	JP

3/3

## PCT REQUEST

TNG-6-PCT

Original (for SUBMISSION) - printed on 17.04.2001 10:12:49 AM

VI-2	Priority claim of earlier national application		
VI-2-1	Filing date	27 April 2000 (27.04.2000)	
VI-2-2	Number	P2000-127191	
VI-2-3	Country	JP	
VI-3	Priority document request		
	The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1, VI-2	
VII-1	International Searching Authority Chosen	European Patent Office (EPO) (ISA/EP)	
VIII	Check list	number of sheets	electronic file(s) attached
VIII-1	Request	3	-
VIII-2	Description	25	-
VIII-3	Claims	4	-
VIII-4	Abstract	1	EZABST00.TXT
VIII-5	Drawings	9	-
VIII-7	TOTAL	42	
	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-18	Figure of the drawings which should accompany the abstract	FIG. 6 (a)	
VIII-19	Language of filing of the international application	English	
IX-1	Signature of applicant or agent	<i>Kurihara Kiyoshi</i>	
IX-1-1	Name (LAST, First)	KURIHARA, Kiyoshi	

## FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported International application	
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-6	International Searching Authority	ISA/EP
10-6	Transmittal of search copy delayed until search fee is paid	

## FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	
------	--	--

1/2

**PCT (ANNEX - FEE CALCULATION SHEET)**

TNG-6-PCT

Original (for SUBMISSION) - printed on 17.04.2001 10:12:49 AM

(This sheet is not part of and does not count as a sheet of the international application)

0	<b>For receiving Office use only</b>	
0-1	International Application No.	
0-2	Date stamp of the receiving Office	
0-4	<b>Form - PCT/RO/101 (Annex)</b>	
0-4-1	PCT Fee Calculation Sheet Prepared using	PCT-EASY Version 2.91 (updated 01.01.2001)
0-9	Applicant's or agent's file reference	TNG-6-PCT
2	Applicant	TOKIN CORPORATION, et al.
12	<b>Calculation of prescribed fees</b>	
12-1	Transmittal fee T	⇒ 18,000
12-2	Search fee S	⇒ 103,000
12-3	International fee	
	Basic fee	
	(first 30 sheets) b1	46,200
12-4	Remaining sheets	12
12-5	Additional amount (X)	1,100
12-6	Total additional amount b2	13,200
12-7	b1 + b2 = B	59,400
12-8	Designation fees	
	Number of designations contained in international application	6
12-9	Number of designation fees payable (maximum 6)	6
12-10	Amount of designation fee (X)	10,000
12-11	Total designation fees D	60,000
12-12	PCT-EASY fee reduction R	-14,000
12-13	Total International fee (B+D-R) I	⇒ 105,400
12-14	Fee for priority document	
	Number of priority documents requested	2
12-15	Fee per document (X)	1,400
12-16	Total priority document fee P	⇒ 2,800
12-17	<b>TOTAL FEES PAYABLE (T+S+I+P)</b>	⇒ 229,200
12-19	Mode of payment	Transmittal fee: revenue stamps Search fee: bank draft International fee: bank draft Priority document fee: revenue stamps

**VALIDATION LOG AND REMARKS**

13-2-1	Validation messages Request	Green? The title of the invention shall be short and precise. Please verify.
--------	-----------------------------	---

2/2

## PCT (ANNEX - FEE CALCULATION SHEET)

TNG-6-PCT

Original (for SUBMISSION) - printed on 17.04.2001 10:12:49 AM

13-2-2	Validation messages States	<p>Green?</p> <p>More designations could be made. The following States have not been designated: AP:( GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW); EA:( AM, AZ, BY, KG, KZ, MD, RU, TJ, TM); EP:( AT, BE, CH, LI, CY, DK, ES, GR, IE, IT, LU, MC, NL, PT, TR); OA:( BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG); AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, LI, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NZ, PL, PT, RO, RU, SD, SE, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW. Please verify.</p>
		<p>Green?</p> <p>One or more states has been deselected from the EP designation. Please verify.</p>
13-2-3	Validation messages Names	<p>Green?</p> <p>Applicant 1.:Telephone No. missing</p>
		<p>Green?</p> <p>Applicant 1.:Facsimile No. missing</p>
		<p>Green?</p> <p>Agent 1.:Telephone No. missing</p>
		<p>Green?</p> <p>Agent 1.:Facsimile No. missing</p>
13-2-6	Validation messages Contents	<p>Yellow!</p> <p>The power of attorney or a copy of the general power of attorney will need to be furnished unless all applicants sign the request form.</p>
13-2-10	Validation messages For receiving Office/International Bureau use only	<p>Green?</p> <p>Verify electronic data for consistency against printed form.</p>

# PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

## PCT

NOTIFICATION OF TRANSMITTAL OF  
THE INTERNATIONAL SEARCH REPORT  
OR THE DECLARATION

(PCT Rule 44.1)

To:

KURIHARA, Kiyoshi  
Nishikan Toranomon Bldg. 4th Fl., 1  
-22-13, Toranomon  
Minatu-ku, Tokyo 105-0001  
JAPAN

Date of mailing  
(day/month/year)

08/11/2001

Applicant's or agent's file reference

TNG-6-PCT

**FOR FURTHER ACTION**

See paragraphs 1 and 4 below

International application No.

PCT/JP 01/03271

International filing date  
(day/month/year)

17/04/2001

Applicant

TOKIN CORPORATION et al.

1. ☒ The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

**Filing of amendments and statement under Article 19:**

The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

**When?** The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

**Where?** Directly to the International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland  
Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority



European Patent Office, P.B. 5818 Patentlaan 2  
NL-2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Federico Bonomelli

## NOTES FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions respectively.

### INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

#### What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

#### When?

Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

#### Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

#### How?

Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

#### What documents must/may accompany the amendments?

##### Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

- (i) the claim is unchanged;
- (ii) the claim is cancelled;
- (iii) the claim is new;
- (iv) the claim replaces one or more claims as filed;
- (v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:  
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."
2. [Where originally there were 15 claims and after amendment of all claims there are 11]:  
"Claims 1 to 15 replaced by amended claims 1 to 11."
3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:  
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or  
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."
4. [Where various kinds of amendments are made]:  
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

**"Statement under article 19(1)" (Rule 46.4)**

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

**It must be in the language in which the international application is to be published.**

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

**Consequence if a demand for international preliminary examination has already been filed**

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

**Consequence with regard to translation of the international application for entry into the national phase**

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>TNG-6-PCT</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/JP 01/03271</b>	International filing date ( <i>day/month/year</i> ) <b>17/04/2001</b>	(Earliest) Priority Date ( <i>day/month/year</i> ) <b>17/04/2000</b>
Applicant  <b>TOKIN CORPORATION et al.</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.  
☒ It is also accompanied by a copy of each prior art document cited in this report.

**1. Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

**6a** \_\_\_\_\_

☐ None of the figures.

## INTERNATIONAL SEARCH REPORT

International Application No

P 01/03271

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H05K9/00 H04M1/02 H04R1/10

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H05K H04R H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 199 09 569 A (MURATA MANUFACTURING CO) 16 September 1999 (1999-09-16)	1,3-7
Y	the whole document	2
Y	---	8
Y	US 5 703 557 A (SAITO NORIO ET AL) 30 December 1997 (1997-12-30)	2
	the whole document	
Y	---	
Y	FR 2 765 069 A (ELECTRICITE DE FRANCE) 24 December 1998 (1998-12-24)	8
	claims 1,6; figure 2Y	
A	---	
A	US 4 742 887 A (YAMAGISHI MAKOTO) 10 May 1988 (1988-05-10)	8
	the whole document	
	---	
	-/--	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents:

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

\*&\* document member of the same patent family

Date of the actual completion of the international search

1 November 2001

Date of mailing of the international search report

08/11/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Toussaint, F

# INTERNATIONAL SEARCH REPORT

International Application No

PO P 01/03271

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>PATENT ABSTRACTS OF JAPAN  vol. 1999, no. 09,  30 July 1999 (1999-07-30)  &amp; JP 11 097246 A (TOKIN CORP),  9 April 1999 (1999-04-09)  abstract</p> <p>-----</p>	1

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PC 01/03271

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
DE 19909569	A	16-09-1999	JP	11260160 A	24-09-1999
			DE	19909569 A1	16-09-1999
			US	6143406 A	07-11-2000
US 5703557	A	30-12-1997	JP	7122433 A	12-05-1995
			CN	1112381 A ,B	22-11-1995
			EP	0660342 A1	28-06-1995
			WO	9502253 A1	19-01-1995
			SG	47449 A1	17-04-1998
FR 2765069	A	24-12-1998	FR	2765069 A1	24-12-1998
			AU	5056698 A	04-01-1999
			EP	0992182 A1	12-04-2000
			WO	9859531 A1	30-12-1998
			TW	408556 B	11-10-2000
US 4742887	A	10-05-1988	DE	3706481 A1	03-09-1987
			DE	8703084 U1	01-10-1987
			FR	2595178 A1	04-09-1987
			GB	2187361 A ,B	03-09-1987
			HK	11991 A	22-02-1991
			KR	9207601 Y1	16-10-1992
JP 11097246	A	09-04-1999	NONE		